Fabrication of Microdevices and ULSI by Combining Surface Treatment and Electroless Metallization

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It was shown that electroless deposition of Ni-P and Ni-B alloys on various materials can be successfully used in production of devices in piezoengineering, microelectronics, electrotechnics, instrument – making, etc. The proposed nanotechnologies are much more advantageous and simpler than other expensive and complicated methods of nanotechnologies.

The developed electroless methods of metallization are widely used in industry. As a result, Au, Ag and Pd were adequately replaced with the alloys of non-precious metals, usage of toxic substances was eliminated and the technology was significantly simplified.

New Nanotechnology on the basis of single conventional optical photolithography

The proposed nanotechnology for the first time allows one to produce nano-sized adjacent elements of different thickness made of various materials (particularly of Si) by single conventional optical UV photolithography. These advantages significantly extend functional capabilities of the devices and simplify removal of undesirable gases and heat dissipation.

The proposed nanomethods are much more advantageous and simpler than other expensive and complicated methods such as e-beam and X-ray lithography or production of devices with nano-sized elements by a light phase shift photomasks. The proposed method allows us to eliminate surface treatment by e-beam. It can save about $4 000 000 (the price of e-beam exposure equipment). It also eliminates application of X-ray masks with gold masking elements.

Scientific basis of the new method of fabricating the photomasks with semitransparent elements and devices with nano-sized elements, consists in the fact that the technology is carried out in such a way that the difference between boundary properties of the modified materials and bulk properties of the same materials are revealed to the utmost.

The proposed nanotechnology helps to solve one of the main problems of the modern microelectronics. It simplifies and makes cheaper the technology of microfabrication of the devices with the nano-sized elements.

The developed nanotechnology is promising for production of nanodevices; nanowires; microelectrodes for new local micro- and nano- electrodeposition and etching techniques; press molds with nano-sized pillars for nanoimprint lithography (NIL); quartz masks for laser-assisted direct imprint (LADI) of nanostructures in silicon (a single excimer laser pulse melts a thin top surface layer of silicon and the mask is pressed into the molten layer); tips of nanowidth for various applications, etc.

In NIL, the thick parts of the mould are physically deformed the resist (by embossing of the mould thick parts into the resist). Thus, the thickness contrast in a resist is formed. Then anisotropic etching in the thinned resist sections is carried out.

The advantages of the proposed design of the quartz mask for LADI are that the mask projections are mechanically stronger (than of the quartz masks available so far) since these transparent tips are mechanically strengthened by the second-group elements located between these tips .

The developed mesoelements are characterized by a combination of unique properties determined by the laws of classical and quantum mechanics. Owing to this fact, it will be possible to overcome the challenging problems of the fabricated nano-sized elements – their instability: a) changes in the mass of nanoelements as a result of adsorption of atoms, ions and molecules, that cause changes in the resonant frequency and b) undesirable influence of even very few defects and impurities on nano-sized elements, that leads to less stability and unreliability of nano-sized elements.

A novel true additive method of fabrication of multiple conducting layers, contact filling materials, dielectric layers and pads on Si, GaAs or other substrates was developed for ULSI by combination of local electroless deposition with the proposed thin layer LIGA, sacrificial layer and chemical mechanical polishing techniques. This additive method entirely excludes the etching of conducting and dielectric films deposited on different levels, and cutting in dielectric layers and reactive ion etching.

The competitive resistless (maskless) method of direct formation of IC elements, photomasks with semitransparent masking elements, in particular with nano-sized elements, and microdevices by means of photoinduced (laser-induced) local anodic oxidation of valve materials, e.g. silicon, and by subsequent selective etching of oxidized regions is proposed.

One of the objects of the present work is resistless direct formation of final elements and devices by means of laser-induced local anodic oxidation of valve materials, for example silicon. The next object is elimination of disadvantages of the LIGA process and available resistless technologies with the aim of expanding the functional capabilities of the device designs. This is achieved by means of resistless direct formation of adjacent elements from the materials of different chemical nature.

We have designed a new device for precise determination of ductility. The ductility of the electrolessly deposited Ni-P coating was studied by bending using a new device.